

***Source-Sink balance and
carbon allocation below ground
in
plants exposed to ozone***

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Outline

- A. Background- Air Quality Standards***
- B. Ecosystem Complexity- Above and Below ground***
- C. Does Ozone Affect Soil Organisms?***
- D. Scaling Plant Level Responses to Ecosystems***



CLEAN AIR ACT

TWO TYPES OF NAAQS

PRIMARY – Protects
Human Health

SECONDARY -
Protects Public
Welfare from
“Adverse Effects”

OZONE – Secondary is
set equal to primary



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CLEAN AIR ACT

SECONDARY NAAQS

PROTECTS AGAINST '*ADVERSE EFFECTS*' TO *PUBLIC WELFARE*

ECOSYSTEMS

FORESTS

CROPS

SOILS



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How do we evaluate ozone impacts on ecosystems?

- Reduced plant growth and yield
- Ecosystem structure or function
 - Altered nutrient cycling
 - Decreased productivity
- Loss of species diversity
- Ecosystem services
 - Clean water
 - Nutrient retention
 - Habitat



Ecosystem Protection

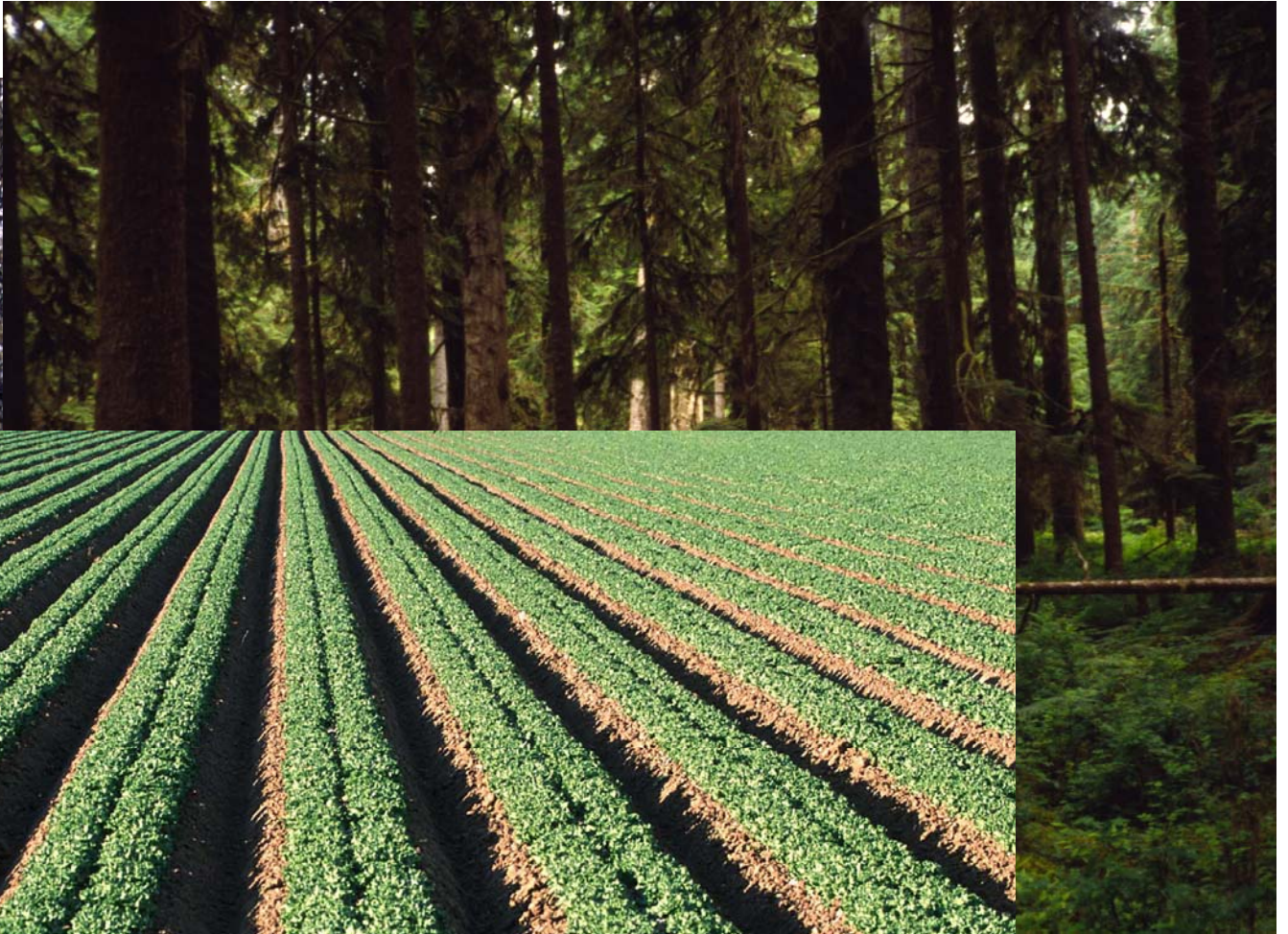


- *Thousands of species- differential sensitivity*
- *Species interactions- individuals not important*
- *Responses over years to decades; landscapes*



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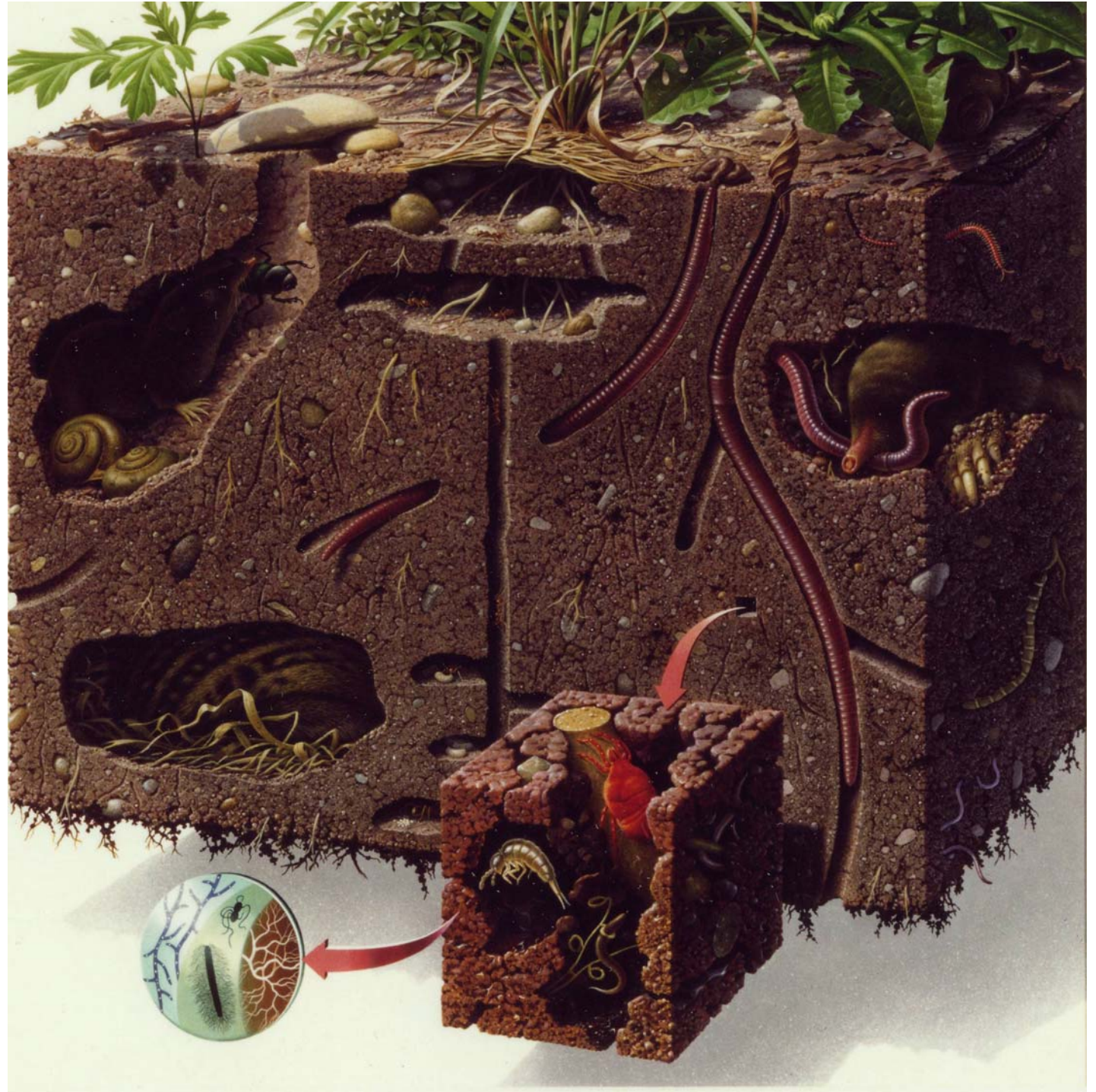


One gram contains:

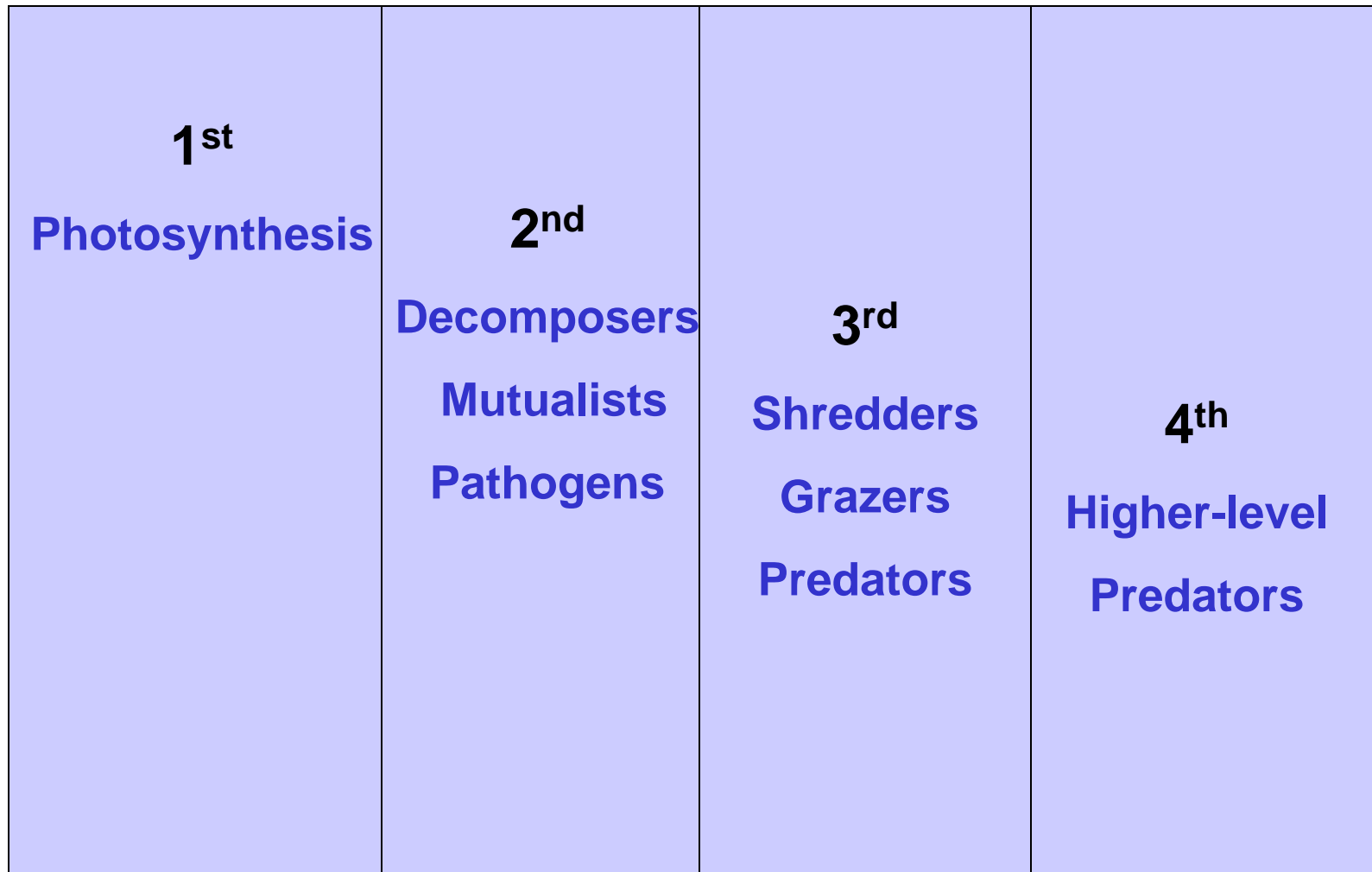
40,000 species
bacteria

7,000 species
fungi

100+ species
invertebrates



Carbon

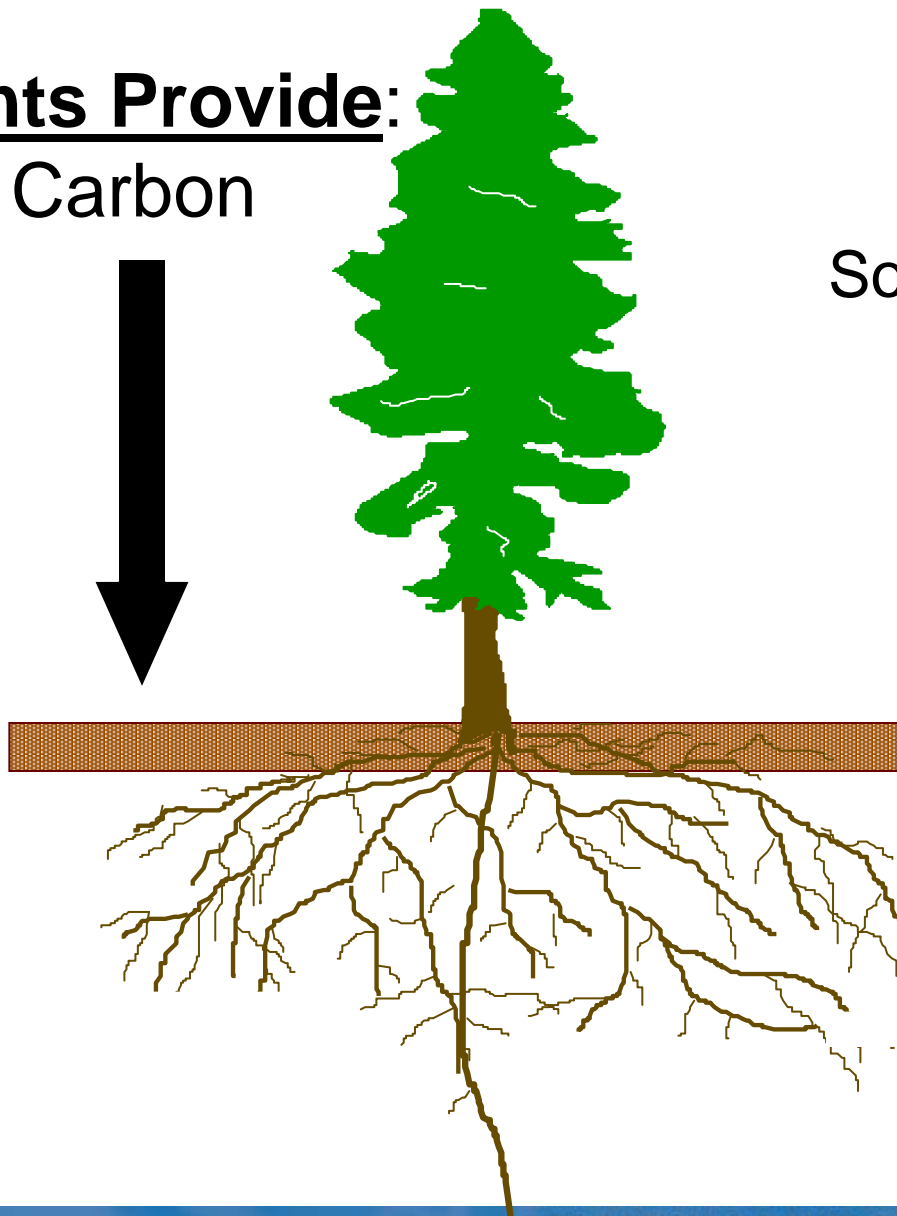


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Plants Provide:

Carbon



Soils Provide:

Nutrient cycling
Soil structure- water retention
Disease suppression
PGR's
Decomposition of toxics



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Healthy ecosystems require healthy soils



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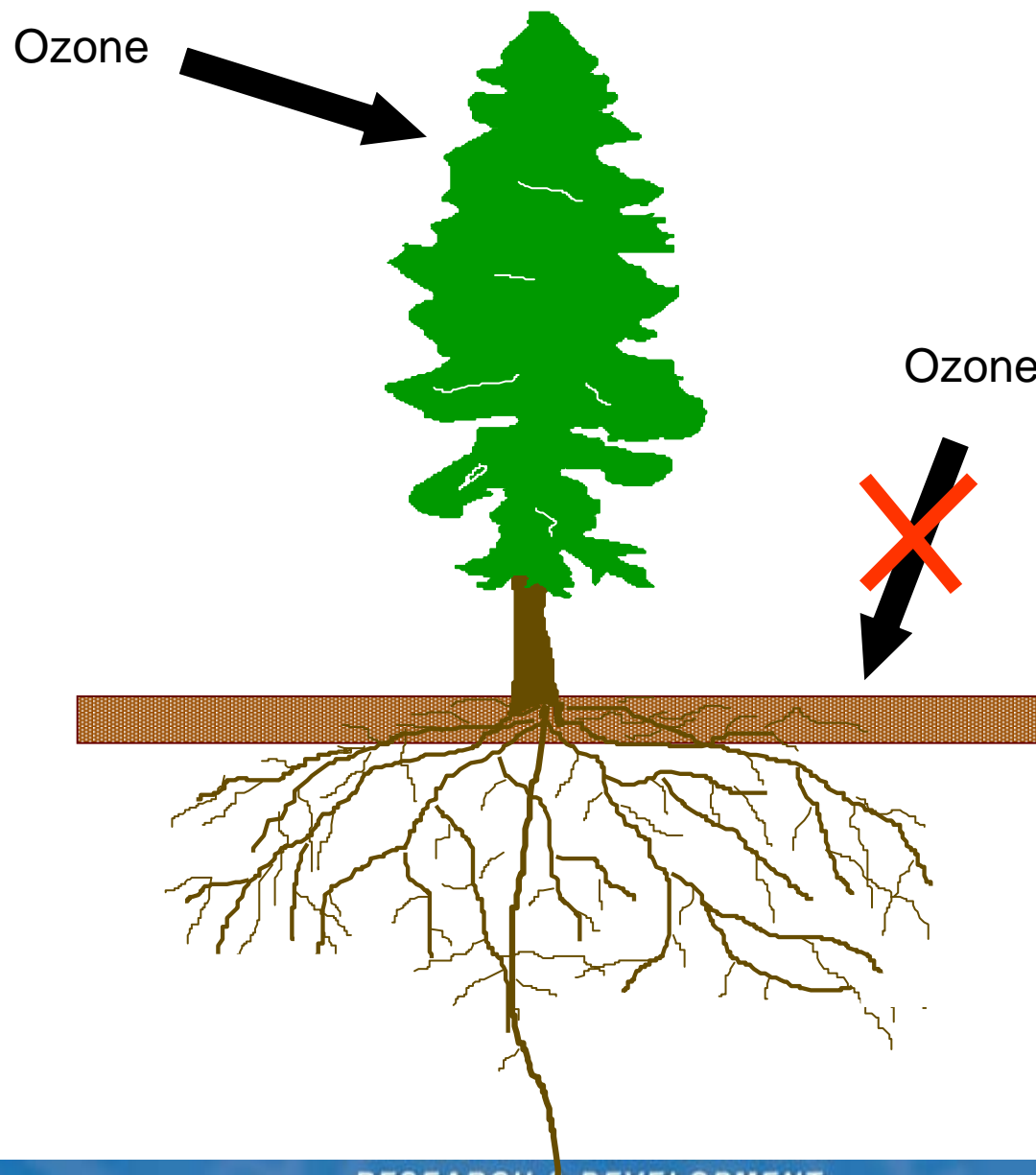
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Does ozone affect soil organisms?



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Leaves = **C Source**

CO₂



Photosynthesis



Carbohydrates



Ozone alters
source-sink
balance



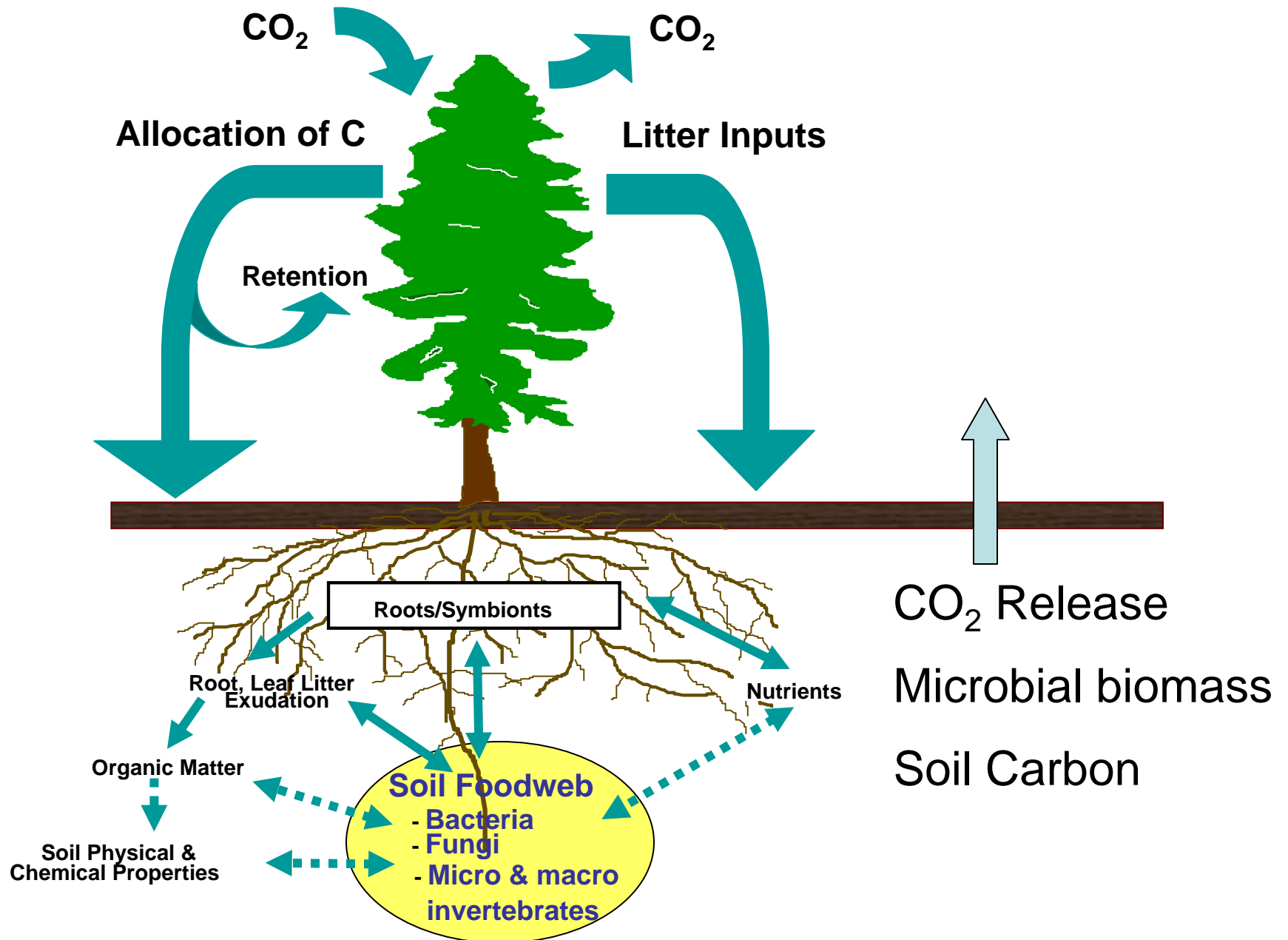
Roots, other = **C Sink**

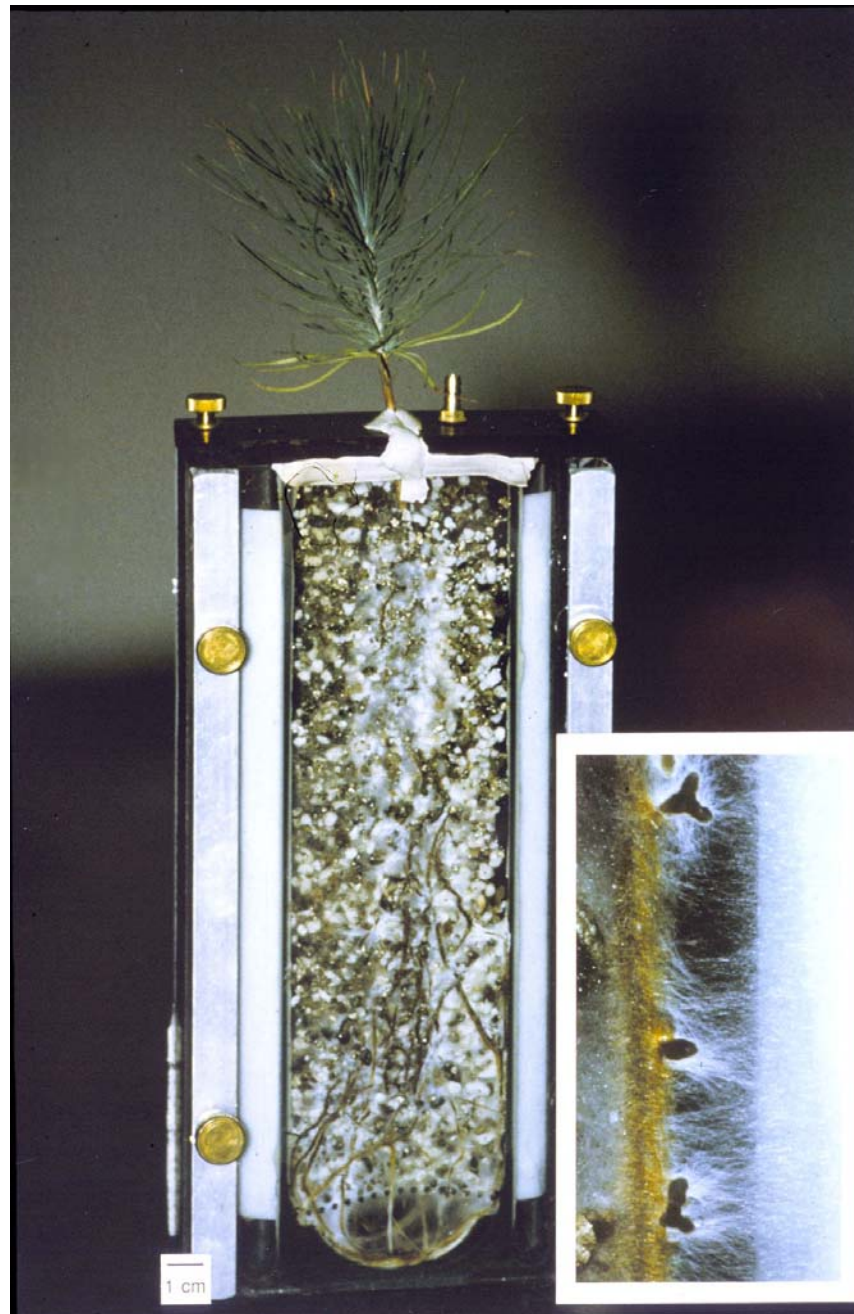


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Ozone and Carbon Movement in Plant and Soil





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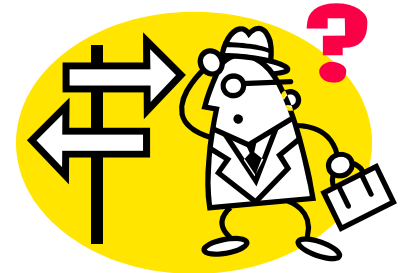


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- *Below ground responses were often unpredictable based on plant-level understanding*
 - *Unable to predict direction of change*
- *Below ground responses occur rapidly, often before above ground responses*
 - *Short life cycle, rapid turnover of soil organisms relative to plants*



Evidence suggests:

- *Ozone may alter ecosystem carbon pools-*
 - *Atmospheric feedback with climate change*
 - *Soils contribute 10X more CO₂ to atmosphere than fossil fuel combustion*
- *Ozone may alter ecosystem nutrient cycling-*
 - *Water quality and plant productivity*
- *Belowground changes may alter vegetation through feedbacks*
 - *Ecosystem services*



"...there are things we know we know. We also know there are known unknowns; that is to say we know there are some things we do not know. But there are also unknown unknowns -- the ones we don't know we don't know."

- Donald Rumsfeld



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